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Correlation and Path Analysis for Yield and its Component Traits in Rice (*Oryza sativa* L.)

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Abstract

The materials used in this study consisted of 31 genotypes including two checks i.e. HPR 1156 and HPR 2656. The material was raised in a randomized block design with three replications. Data was recorded on days to 50% flowering, days to 75% maturity, plant height, panicle length, grains/panicle, spikelets/panicle, yield/plant, 1000-grain weight, grain length, grain breadth, L:B ratio, protein content, aroma, yield/plot, reaction to leaf and neck blast. The data were analyzed as per standard statistical procedures. Genotypic correlation was higher in magnitude than the phenotypic correlation coefficient, indicating more genetic association among the various traits. Grain yield/plant exhibited significantly positive association with days to 50% flowering, panicle length, grains/panicle, spikelets/panicle and grain breadth at both genotypic level and phenotypic level. Thus the results indicate that improvement in grain yield/plant can be obtained by laying more emphasis on above characters. Path analysis revealed the highest positive direct effect of grains/panicle on the grain yield followed by L/B ratio, 1000-grain weight, and yield/plant and emphasis may be laid on these characters in future rice breeding programmes.

Key words: Rice, genotypic correlation, phenotypic correlation, path analysis.

Introduction

Rice *(Oryza sativa* L.) is one of the major food crop of world especially of the most Asian countries like China, India, Pakistan, Bangladesh, Vietnam, Korea. Rice is placed on second position in cereal production around the globe. Rice is the most staple food of Asia. More than 90% of the world's rice is grown and consumed in Asia, where 60% of the world's population lives. Rice is grown worldwide over an area 160.6 million hectares with total production of 492.2 million tones. Area under rice in India is 42.2 million hectares with production of 104 million tones (Anonymous 2016). The study of correlation is important to identify traits for which selection can be made. So it is the study of the degree of association between characters which is given by the coefficient of correlation is a useful guide in the plant breeding programmes, as it helps the breeder to concentrate on those characters that are of direct relevance. It is a measure of the degree of association between two traits worked at the same time (Hayes et al. 1995). The extent of observed relationship between two characters is known as simple phenotypic correlation. As such it does not give the true picture of the relationship between two characters because along with genetic values, it includes environmental influence on the covariance between the two characters; the measure is turned as environmental correlation. Johnson et al. (1955) revealed that estimates of genotypic and phenotypic correlation among characters are useful in planning and evaluating breeding programmes.

Path coefficient analysis of yield and its related parameters specifies the cause and measure the relative importance of each variable. The yield potentially of each variety can be exploited if the relative importance of each component is ascertained and is increased to a desired degree by suitable management practices. As yield components vary independently among varieties, study on the relative importance of each component for different varieties is essential. Therefore in addition to determining the inter-relationship among yield components on one hand and between yields and its components causes of association on the other hand, it is important to know the direct effects and the interactions in the form of indirect effects of these traits on the yield.

Materials and Methods

The investigation was carried out on 31 advance breeding lines of Rice and Wheat Research Centre, Malan, and 2 checks namely, HPR-1156 and HPR-2656. These lines were evaluated in Randomized Block Design with three replications. Data was recorded on days to 50% flowering, days to 75% maturity, plant height, panicle length, grains/panicle, spikelets/panicle, yield/plant, 1000-grain weight, grain length, grain breadth, L:B ratio, protein content, aroma, yield/plot, reaction to leaf and neck blast. The data were analyzed as per standard statistical procedures. Phenotypic, genotypic and environmental coefficients of correlation were worked out following the procedure of Al-Jibouri et al. (1958) and Dewey and Lu (1959). The path analysis of important component traits and quality traits with grain yield was done following Dewey and Lu (1959).

Results and Discussion

The estimation of phenotypic correlation (Table 1) showed that days to 50% flowering was significantly and positively correlated with days to 75% maturity (0.574), panicle length (0.529), grain/panicle (0.364), spikelets/panicle (0.399) and yield/plant (0.280) but it was significantly negative correlated with plant height (-0.341), 1000-grain weight (-0.277) and yield/plot (-0.206). Days to 75% maturity showed significantly positive correlation with panicle length (0.603), grains/panicle (0.373), spikelets/panicle (0.384) and L:B ratio (0.300). On the other hand correlation were significantly negative with plant height (-0.229), 1000-grain weight (-0.411), grain breadth (-0.378) and yield/plot (-0.275). Plant height exhibited significantly positive correlation with grain breadth (0.234) but it was significantly negative correlated with panicle length (-0.246). Panicle length showed significantly and positively correlation with grains/panicle (0.668), spikelets/panicle (0.678) yield/plant (0.417) and L:B ratio (0.257) but it was significantly negative correlated with 1000-grain weight (-0.297) and yield/plot (-0.226).

Grains/panicle had significantly positive correlation with spikelets/panicle (0.758) yield/plant (0.521), it was significantly negative correlated with 1000-grain weight (-0.285) and protein content (-0.209). Spikelets/panicle exhibited significantly positive correlation with yield/plant (0.491) but it was significantly negative correlated with 1000-grain weight (-0.424) and yield/plot (-0.341). Yield/plant showed significantly and positively correlation with grain breadth (0.232), and significantly negative with protein content (-0.219).

1000-grain weight showed significantly and positively correlation with grain length (0.238), grain breadth (0.425) and yield/plot (0.353), and it was significantly negative correlated with L/B ratio (-0.197). Grain length had significantly positive correlation with L/B ratio (0.789), and it was significantly negative correlated with grain breadth (-0.361) and protein content (-0.269). Grain breadth showed significantly and negative correlation with L/B ratio (-0.730). Protein content had significant negative correlation with yield/plot (-0.243). In order to increase grain yield, stress should be given on those characters which are positively correlated with yield. 1000-grain

Table 1: Estimation of phenotypic correlation coefficient among various yield, morphological and quality traits in rice genotypes

Traits	Days to 75% maturity	Plant height	Panicle length	Grains / panicle	Spike-lets / panicle	Yield / plant	1000-grain weight	Grain length	Grain breadth	L:B ratio	Protein content	Yield / plot
Days to 50% flowering	0.574*	-0.341*	0.529*	0.364*	0.399*	0.280*	-0.277*	0.020	-0.121	0.133	0.139	-0.206*
Days to 75% maturity		-0.229*	0.603*	0.373*	0.384*	0.158	-0.411*	0.037	-0.378*	0.300*	-0.041	-0.275*
Plant height			-0.246*	-0.060	-0.072	0.148	0.051	-0.112	0.234*	-0.195	-0.181	0.029
Panicle length				0.668*	0.678*	0.417*	-0.297*	0.157	-0.182	0.257*	-0.135	-0.226*
Grains / panicle					0.758*	0.521*	-0.285*	-0.137	0.020	-0.020	-0.209*	0.011
Spikelets / panicle						0.491*	-0.424*	-0.123	-0.037	0.003	-0.180	-0.341*
Yield / plant							-0.006	-0.015	0.232*	-0.082	-0.219*	0.132
1000-grain weight								0.238*	0.425*	-0.197*	-0.118	0.353*
Grain length									-0.361*	0.789*	-0.269*	0.065
Grain breadth										-0.730*	0.051	0.166
L:B ratio											-0.180	-0.063
Protein content												-0.243*

*Significant at 5% level of significance weight had significant positive correlation with grain yield. Similar results were observed by Das et al. (1992), Chandra et al. (2009) and Ratna et al. (2015).

The analysis of the genotypic correlation (Table 2) showed that the days to 50% flowering had significant positive correlation with days to 75% maturity (0.579), panicle length (0.565), grain/panicle (0.393), spikelets/panicle (0.417) and yield/plant (0.317). It was significantly negative with plant height (-0.348), 1000-grain weight (-0.300) and yield/plot (-0.219). Days to 75% maturity showed significantly positive correlation with panicle length (0.650), grains/panicle (0.403), spikelets/panicle (0.404) and L/B ratio (0.325), it was significantly negative with plant height (-0.241), 1000-grain weight (-0.460), grain breadth (-0.495) and yield/plot (-0.299). Plant height showed significantly positive correlation with grain breadth (0.328), and it was significantly negative with panicle length (-0.279), L:B ratio (-0.244) and protein content (-0.196). Panicle length showed significantly positive correlation with grains/panicle (0.754), spikelets/panicle (0.735), yield/plant (0.482), grain length (0.210) and L:B ratio (0.330), and it was significantly negative with 1000-grain weight (-0.327), grain breadth (-0.279) and yield/plot (-0.250). Grains/panicle showed significantly positive correlation with spikelets/panicle (0.818) and yield/plant (0.600), and it was significantly negative with 1000-grain weight (-0.300) and protein content (-0.224). Spikelets/panicle showed significantly positive correlation with yield/plant (0.554), and it was significantly negative with 1000-grain weight (-0.467) and yield/plot (-0.375). Yield/plant showed significantly positive correlation with grain breadth (0.381) and significantly negative with protein content (-0.256). 1000-grain weight showed significantly positive correlation with grain length (0.245), grain breadth (0.549) and yield/plot (0.407), it had negative correlation with L:B ratio (-0.234). Grain length showed significantly positive correlation with L:B ratio (0.848), and it was significantly negative with grain breadth (-0.600) and protein content (-0.333). Grain breadth showed significantly positive correlation with yield/plot (0.226), it was negatively correlated with L:B ratio (-0.920). L:B ratio showed significant negative correlation with protein content (-0.199). Protein content showed significant negative correlation with yield/plot (-0.279).

The values of genotypic correlation coefficient were generally higher than the corresponding phenotypic and environmental correlation coefficient for most of the characters studied suggesting strong inherent relationship between various characters. 1000-grain weight and grain breadth had significant positive correlation with grain yield. Similar results were observed by Rupika et al. (2012) and Lakshmi et al. (2014) for 1000-grain weight and grain breadth.

Table 2: Estimation of genotypic correlation coefficient among various yield, morphological and quality traits in rice genotypes

Traits	Days to maturity	Plant height	Yield per plant	Panicle length	Grains per panicle	Spikelets per panicle	1000-grain weight	Grain length	Grain breadth	L:B ratio	Protein content	Yield per plot
50% flowering	0.579*	-0.348*	0.565*	0.393*	0.417*	0.317*	-0.300*	0.046	-0.160	0.164	0.146	-0.219*
Days to 75% maturity		-0.241*	0.650*	0.403*	0.404*	0.174	-0.460*	0.038	-0.495*	0.325*	-0.043	-0.299*
Plant height			-0.279*	-0.085	-0.093	0.135	0.066	-0.153	0.328*	-0.244*	-0.196*	0.064
Panicle length				0.754*	0.735*	0.482*	-0.327*	0.210*	-0.279*	0.330*	-0.139	-0.250*
Grains/panicle					0.818*	0.600*	-0.300*	-0.132	0.036	-0.016	-0.224*	0.031
Spikelets/panicle						0.554*	-0.467*	-0.083	-0.028	0.049	-0.186	-0.375*
Yield /plant							0.011	-0.035	0.381*	-0.106	-0.256*	0.133
1000-grain weight								0.245*	0.549*	-0.234*	-0.150	0.407*
Grain length									-0.600*	0.848*	-0.333*	0.052
Grain breadth										-0.920*	0.072	0.226*
L:B ratio											-0.199*	-0.056
Protein content												-0.279*

*Significant at 5% level of significance

At the phenotypic level, grains/panicle (0.563) had the highest positive direct effect (Table 3) on the grain yield followed by yield/plant (0.275), 1000-grain weight (0.077), L:B ratio (0.060) and grain breadth (0.008). However, days to 50% flowering (-0.012), days to 75% maturity (-0.170), plant height (-0.158), panicle length (-0.138), spikelets/panicle (-0.772), grain length (-0.070) and protein content (-0.256) had negative direct effects on yield/plot. At the genotypic level, L/B ratio (1.006) had the highest positive direct effect on the grain yield followed by grains/panicle (0.795), 1000-grain weight (0.614), yield/plant (0.359) and days to 50% flowering (0.146). However, days to 75% maturity (-0.442), plant height (-0.052), panicle length (-0.178), spikelets/panicle (-0.904), grain length (-1.133), grain breadth (-0.261) and protein content (-0.318) had negative direct effects on yield/plot. At both genotypic and phenotypic levels grain/panicle, 1000-grain weight, yield/plant, grain length and L:B ratio had highest positive correlation. So, grains/panicle is the most important character as it exhibited high positive direct effect on grain yield at both genotypic and phenotypic level. Similar results were obtained by Meena et al. (2016). Kalyan et al. (2017) reported that number of filled grains/panicle had highest positive effect on grain yield followed by 1000-grain weight. Concurrently, at genotypic level spikelets/panicle had highest indirect effect on grain yield via grains/panicle

Table 3: Estimates of direct and indirect effects at phenotypic and genotypic level for different traits in rice genotypes

Traits		Days to 50% flowering	Days to 75% maturity	Plant height	Panicle length	Grains /panicle	Spikelets/ panicle	Yield/ plant	1000-grain weight	Grain length	Grain breadth	L:B ratio	Protein content	Correlation with grain yield per plot
Days to 50% flowering	P	**-0.012**	-0.097	0.054	-0.073	0.205	-0.308	0.077	-0.021	-0.001	-0.001	0.008	-0.036	-0.206*
	G	**0.146**	-0.256	0.018	-0.101	0.312	-0.377	0.114	-0.184	-0.052	0.042	0.165	-0.046	-0.219*
Days to 75% maturity	P	-0.007	**-0.170**	0.036	-0.083	0.210	-0.297	0.044	-0.032	-0.003	-0.003	0.018	0.011	-0.275*
	G	0.085	**-0.442**	0.013	-0.116	0.320	-0.365	0.063	-0.283	-0.043	0.129	0.327	0.014	-0.299*
Plant height	P	0.004	0.039	**-0.158**	0.034	-0.034	0.055	0.041	0.004	0.008	0.002	-0.012	0.046	0.029
	G	-0.051	0.107	**-0.052**	0.050	-0.067	0.084	0.048	0.041	0.174	-0.086	-0.245	0.062	0.065
Panicle length	P	-0.006	-0.102	0.039	**-0.138**	0.376	-0.524	0.114	-0.023	-0.011	-0.001	0.015	0.035	-0.226*
	G	0.083	-0.287	0.015	**-0.178**	0.599	-0.664	0.173	-0.201	-0.238	0.073	0.332	0.044	-0.250*
Grains /panicle	P	-0.004	-0.063	0.009	-0.092	**0.563**	-0.585	0.143	-0.022	0.010	0.000	-0.001	0.053	0.011
	G	0.057	-0.178	0.004	-0.134	**0.795**	-0.740	0.216	-0.184	0.150	-0.010	-0.016	0.071	0.031
Spikelets/ panicle	P	-0.005	-0.065	0.011	-0.094	0.426	**-0.772**	0.135	-0.033	0.009	0.000	0.000	0.046	-0.341*
	G	0.061	-0.179	0.005	-0.131	0.650	**-0.904**	0.199	-0.287	0.094	0.007	0.049	0.059	-0.375*
Yield/ plant	P	-0.003	-0.027	-0.023	-0.057	0.293	-0.379	**0.275**	-0.001	0.001	0.002	-0.005	0.056	0.132
	G	0.046	-0.077	-0.007	-0.086	0.477	-0.501	**0.359**	0.007	0.039	-0.100	-0.107	0.081	0.133
1000-grain weight	P	0.003	0.070	-0.008	0.041	-0.161	0.327	-0.002	**0.077**	-0.017	0.003	-0.012	0.030	0.353*
	G	-0.044	0.204	-0.003	0.058	-0.238	0.422	0.004	**0.614**	-0.278	-0.144	-0.236	0.048	0.407*
Grain length	P	0.000	-0.006	0.018	-0.022	-0.077	0.095	-0.004	0.018	**-0.070**	-0.003	0.047	0.069	0.065
	G	0.007	-0.017	0.008	-0.037	-0.105	0.075	-0.012	0.151	**-1.133**	0.157	0.853	0.106	0.052
Grain breadth	P	0.001	0.064	-0.037	0.025	0.011	0.028	0.064	0.033	0.025	**0.008**	-0.044	-0.013	0.166
	G	-0.023	0.219	-0.017	0.050	0.029	0.025	0.137	0.337	0.680	**-0.261**	-0.926	-0.023	0.226*
L:B ratio	P	-0.002	-0.051	0.031	-0.036	-0.011	-0.002	-0.022	-0.015	-0.055	-0.006	**0.060**	0.046	-0.063
	G	0.024	-0.144	0.013	-0.059	-0.012	-0.044	-0.038	-0.144	-0.961	0.241	**1.006**	0.063	-0.056
Protein content	P	-0.002	0.007	0.028	0.019	-0.118	0.139	-0.060	-0.009	0.019	0.000	-0.011	**-0.256**	-0.243*
	G	0.021	0.019	0.010	0.025	-0.178	0.168	-0.092	-0.092	0.378	-0.019	-0.200	**-0.318**	-0.279*

Residual effect at phenotypic level (P)= 0.05643

Residual effect at genotypic level (G)= 0.28292

** Significant at 1% level of significance

Bold values indicate direct effects

followed by yield/plant via grains/panicle; grain length via L:B ratio; 1000-grain weight via spikelets/panicle. At phenotypic level spikelets/panicle had highest indirect effect on grain yield via grains/panicle followed by panicle length via grains/panicle, yield/plant via grains/panicle, 1000-grain weight via spikelets/panicle.

In general, genotypic correlation was higher in magnitude than the phenotypic correlation coefficient, indicating more genetic association among the various traits. Grain yield/plant exhibited significantly positive association with days to 50% flowering, panicle length, grains/panicle, spikelets/panicle and grain breadth at both genotypic level and phenotypic level. Thus the results indicate that improvement in grain yield/plant can be obtained by laying more emphasis on above characters. Correlation coefficient at the genotypic level also showed similar trends as at the phenotypic correlation level.

Path analysis revealed the highest positive direct effect of grains/panicle on the grain yield followed by L:B ratio, 1000-grain weight, yield/plant and days to 50% flowering at genotypic level. However, at phenotypic level grains/panicle had maximum contribution towards the grain yield followed by yield/plant, 1000-grain weight, grain length and L:B ratio. Concurrently, at genotypic level spikelets/panicle had highest indirect effect on grain yield via grains/panicle followed by yield/plant via grains/panicle; grain length via L:B ratio; 1000-grain weight via spikelets/panicle. At phenotypic level spikelets/panicle had highest indirect effect on grain yield via grains/panicle followed by panicle length via grains/panicle, yield/plant via grains/panicle, 1000-grainweightviaspikelets/panicle.

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